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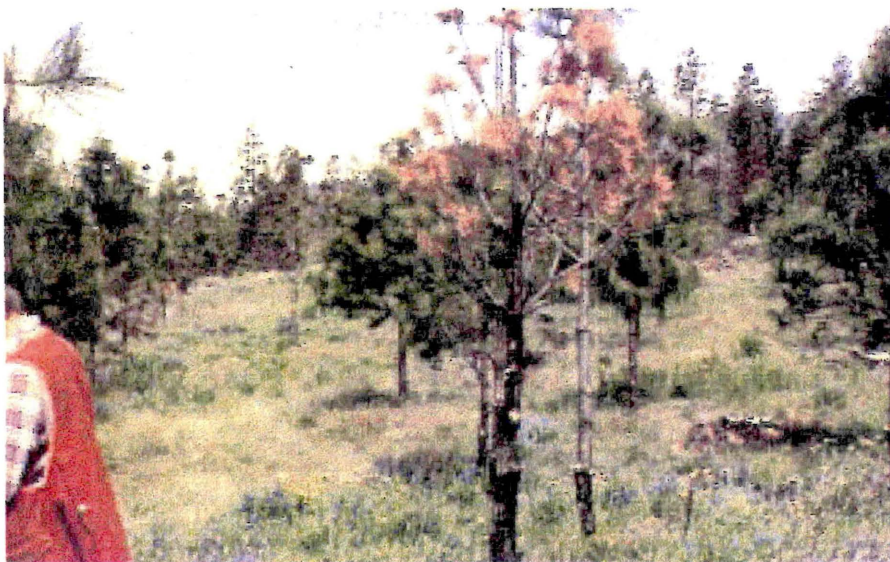
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Insect and Pathogen Survey of National Forest Seed Orchards and Evaluation Plantations in Washington

February, 1997



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INTRODUCTION

Many seed orchards and evaluation plantations have been established on the Colville, Mt Baker-Snoqualmie, Okanogan, and Wenatchee National Forests in Washington. Entomologists and pathologists have visited several of these facilities in response to requests from Districts to diagnose causes of obvious damage to trees. In 1996 we surveyed 21 National Forest seed orchards and evaluation plantations to determine the species of insects and pathogenic organisms and other damaging agents present and estimate the percentage of trees affected. This report describes the survey and findings.

OBJECTIVES

The objectives of this survey were to determine which insect species, pathogenic organisms, and abiotic agents are affecting trees in seed orchards and evaluation plantations and provide estimates of the percentages of trees affected by these agents.

PROCEDURES

The survey was done in seed orchards and evaluation plantations in which the trees had been planted at least five years. A list of sites was provided by the area tree improvement specialists and District Silviculturists. Several units on these lists were not surveyed because they were close to other units that were surveyed, District personnel indicated survival was poor following planting, or lack of time.

The surveys were done by placing 10-foot wide transects along compass bearings that crossed the units. Transects were not placed parallel to rows of planted trees. Each planted tree

within the transect was examined for obvious insect infestation and disease damage, as well as damage caused by abiotic agents. This was done by examining foliage on several branches, while at the same time looking at the stems and branches for damage. Roots were not examined unless the trees were dead or dying and root problems were suspected. Tree examinations were to take less than two minutes per tree. We attempted to examine at least 150 trees per unit; this was not always possible.

Site data collected included year of planting, elevation, aspect, and whether stumps had been removed as part of facility establishment. Tree data included species of insects and pathogens or effects caused by these agents, animal feeding, and damage caused by abiotic agents, in particular weather and mechanical damage. In cases where the cause of damage could not be identified it was recorded as unknown. Trees were classified as alive or dead. We did not record any tree family data.

After about half the seed orchards and evaluation plantations on the list had been surveyed the procedure was modified slightly to include a general walk-through reconnaissance. The recon survey allowed the surveyors to examine trees that were obviously damaged, dying, or dead but were not included in the transects. Observations made during the reconnaissance were included in comments about each unit but they were not used to estimate numbers of trees affected.

Photographs were taken in many of the seed orchards and evaluation plantations.

Results

Survey results are reported by individual seed orchards and evaluation plantations.

Colville National Forest. The survey was done in three seed orchards on the Colville National Forest. Three surveys were made at Cedar Creek because of the different trees species present.

Flowery Trail seed orchard	Newport District
Species surveyed Douglas-fir	Years Planted 7
Trees examined 139	Date surveyed June 12, 1996

Damaging Agents	Percent Trees
No damage	6.5
Animal feeding	0.7
Broken top	0.7
Mechanical, stem	2.9
Multiple stem/top	4.3

Dermea canker	7.2
Rhabdocline needlecast	0.7
Swiss needlecast	0.7
Douglas-fir bark miner	12.2
Cooley gall adelgid	83.4
Needle midge	55.4
Dead/dying trees	0.0

Comments: Conspicuous top and branch killing has been occurring for several years. The most likely cause appears to be a complex of Douglas-fir bark miner feeding and subsequent infection of the feeding site by the canker fungus, *Dermea pseudotsugae*. The District has been clipping and disposing of affected branches and tops. Damage is still continuing, but the frequency of infection appears to be getting lower as the trees increase in size.

Tee Pee seed orchard	Sullivan Lake District
Species surveyed	Englemann spruce
	Years planted 7
Trees examined	243
	Date surveyed June 12, 1996
Damaging Agents	Percent Trees
No damage	23.0
Broken top	0.4
Mechanical, stem	0.4
Top dieback	4.5
Branch dieback	0.8
Multiple stem/top	15.2
Cooley gall adelgid	67.5
Dead/dying trees	0.0

Comments: Spruce top and branch killing has been occurring at Tee Pee for several years. Causes of the damage have not been determined. The District has removed many affected trees and clipped dead tops. Damage appears to be less frequent as the trees increase in size. Spruce weevil was found affecting very small numbers of trees on a previous visit to the seed orchard, however no damage from this insect was found on the transects.

Cedar Creek seed orchard	Colville District
Species surveyed	Lodgepole pine
	Years planted 7
Trees examined	114
	Date surveyed June 13, 1996
Damaging Agents	Percent Trees
No damage	65.8
Multiple stem/top	2.6
Mechanical, stem	0.9
Top dieback	0.9
Fertilizer burn	3.5
Dead/dying trees	0.0

Comments: The trees had a recent hand applied granular fertilizer treatment. Four trees were found with foliage burn from clumps of fertilizer lodged in the needles. Sirococcus tip blight was diagnosed on at least one lodgepole pine sample collected from

the seed orchard in 1995, but was not seen on this survey.

Cedar Creek seed orchard	Colville District
Species surveyed Englemann spruce	Years planted 7
Trees examined 111	Date surveyed June 13, 1996
Damaging Agents	Percent Trees
No damage	4.5
Multiple stem/top	16.2
Cooley gall adelgid	95.5
Dead/dying trees	0.0

Comments: Armillaria root rot was previously found in the spruce plantings at Cedar Creek, but no affected trees were found on the transects. Almost all trees have Cooley gall adelgid infestations, but there are few to no adverse effects.

Cedar Creek seed orchard	Colville District
Species surveyed Douglas-fir	Years planted 7
Trees examined 91	Date surveyed June 13, 1996
Damaging Agents	Percent Trees
No damage	0.0
Broken top	5.5
Mechanical, stem	4.4
Multiple stem	9.9
Top dieback	1.1
Fertilizer burn	2.2
Rhabdocline needlecast	70.3
Douglas-fir bark miner	1.1
Cooley gall adelgid	75.8
Needle midge	62.6
Dead/dying trees	2.2

Comments: Rhabdocline needlecast infection was common. The disease does not appear to be adversely affecting survival or growth. The Cedar Creek site is cool and moist and probably provides good conditions for infection. This disease is likely to affect a high percentage of trees for several years. Sirococcus tip blight was diagnosed on samples collected from this seed orchard in previous years, but was not seen on this survey.

Wenatchee National Forest: A total of 15 separate sites were surveyed. Time did not allow any sites on the Naches District to be examined.

Camas Creek seed orchard	Leavenworth District
Species surveyed Ponderosa pine	Years planted 11
Trees examined 174	Date surveyed May 1, 1996
Damaging Agents	Percent Trees
No damage	34.5
Frost	0.6

Broken top	1.1
Mechanical, stem	4.6
Multiple top	1.1
Red band needle blight	0.6
Red turpentine beetle	1.7
Pitch moth	5.7
Western pine shoot borer	56.3
Dead/dying trees	0.0

Comments: Armillaria root rot has been found killing trees at Camas Creek, however none were found on the transects. The District has been removing trees diagnosed with Armillaria root disease. More than half of the trees have been infested by the western pine shoot borer, however the number of laterals and tops affected is generally low on the infested trees. This insect should be monitored because it has the potential to affect cone production in the future.

Camas Creek seed orchard	Leavenworth District
Species surveyed	Ponderosa pine
	Years planted 11
Trees examined	150
	Date surveyed September 18, 1996
Damaging Agents	Percent Trees
No damage	46.0
Red turpentine beetle	0.7
Scythropus weevil	1.3
Pitch moth	4.7
Western pine shoot borer	50.0
Dead/dying trees	0.0

Comments: The percentage of trees infested by western pine shoot borer remained almost the same as when the seed orchard was surveyed in May.

North Corner Evaluation Plantation	Leavenworth District
Species surveyed	Douglas-fir
	Years planted 8
Trees examined	225
	Date surveyed May 15, 1996
Damaging Agents	Percent Trees
No damage	4.0
Frost	15.5
Drought	1.8
Broken branch	5.3
Broken top	6.2
Mechanical, stem	1.3
Multiple stem/top	14.2
Stem unknown	0.9
Cooley gall adelgid	76.4
Needle midge	72.9
Black stain root disease	0.9
Dead/dying trees	1.7

Comments: Frost has affected many trees in the low portion of the plantation. Black stain root disease was found in four planting locations. The disease is still killing trees.

North End Evaluation Plantation Leavenworth District
 Species surveyed Douglas-fir Years planted 7
 Trees examined 161 Date surveyed July 16, 1996

Damaging Agents	Percent trees
No damage	2.5
Broken branch	0.6
Broken top	7.4
Mechanical, stem	1.9
Multiple stem/top	10.1
Cooley gall adelgid	88.8
Needle midge	65.8
Laminated root rot	0.6
Root disease unknown	0.6
Dead/dying trees	1.2

Comments: Laminated root rot was seen in only one location in this plantation. Stumps had not been removed.

Duncan Ridge seed orchard Entiat District
 Species surveyed Douglas-fir Years planted 7
 Trees examined 204 Date surveyed June 19, 1996

Damaging Agents	Percent Trees
No damage	0.0
Snow break	3.4
Animal feeding	2.4
Broken branch	12.2
Broken top	13.2
Mechanical, stem	2.9
Multiple stem/top	19.1
Top dieback	3.4
Branch dieback	2.0
Black stain root disease	1.5
Brown felt foliage disease	25.5
Cooley gall adelgid	77.4
Needle midge	44.6
Western spruce budworm	1.5
Dead/dying trees	2.0

Comments: This seed orchard has a substantial amount of damage from abiotic agents. Annosus root disease was found during the recon survey but was not seen on the transects. Several trees affected by black stain root disease were found during the recon survey.

Duncan Ridge evaluation plantation Entiat District
 Species surveyed Douglas-fir Years planted 8
 Trees examined 129 Date surveyed June 20, 1996

Damaging Agents	Percent Trees
No damage	0.0
Snow break	3.9
Animal feeding	1.6

Broken branch	4.7
Broken top	8.5
Mechanical, stem	0.8
Multiple top	2.3
Branch dieback	0.8
Brown felt foliage disease	1.6
Cooley gall adelgid	93.0
Needle midge	69.0
Dead/dying trees	0.8

Comments: Several black stain root disease killed trees were found during a recon survey. The evaluation plantation is quite brushy and many trees are experiencing damage from abiotic agents.

Lone Peak seed orchard	Entiat District
Species surveyed Douglas-fir	Years planted 11
Trees examined 161	Date surveyed June 5, 1996
Damaging Agents	Percent Trees
No damage	28.0
Snow break	0.6
Broken branch	1.2
Broken top	1.9
Mechanical, stem	0.6
Multiple top	6.2
Rhabdocline needlecast	1.9
Swiss needlecast	0.6
Cooley gall adelgid	36.0
Needle midge	59.0
Dead/dying trees	0.6

Comments: Trees in the seed orchard appear to be in good condition.

Mud Creek seed orchard	Entiat District
Species surveyed Ponderosa pine	Years planted 16
Trees examined 153	Date surveyed June 4, 1996
Damaging Agents	Percent Trees
No damage	24.8
Broken branch	0.7
Broken top	2.0
Fire injury	35.3
Mechanical, stem	6.5
Multiple stem/top	6.5
Western gall rust	3.9
Comandra rust	0.7
Red turpentine beetle	0.7
Pitch moth/Dioryctria	26.8
Western pine shoot borer	17.0
Dead/dying trees	1.3

Comments: Many trees in this seed orchard were killed or injured by the Tyee Fire. Attacks by Sequoia pitch moth or Dioryctria

moths are concentrated on trees that have bole scorch. Western pine shoot borer attacks are common. This insect should be monitored because it has the potential to affect cone production in the future.

Cream Soda evaluation plantation Lake Wenatchee District
 Species surveyed Douglas-fir Years planted 8
 Trees examined 150 Date surveyed July 18, 1996

Damaging Agents	Percent Trees
No damage	1.3
Animal feeding	25.3
Broken top	4.7
Mechanical, stem	3.3
Multiple stem/top	14.7
Top dieback	0.7
Brown felt foliage disease	5.3
Needle rust	68.0
Cooley gall adelgid	84.7
Needle midge	66.0
Dead/dying trees	0.0

Comments: This is brushy plantation. Much of the mechanical damage is associated with the competing brush. The high incidence of needle rust may also be associated with the dense brush because it helps keep relative humidity high around the overtopped firs.

Faultline #5 evaluation plantation Lake Wenatchee District
 Species surveyed Douglas-fir Years planted 8
 Trees examined 154 Date surveyed July 17, 1996

Damaging Agents	Percent Trees
No damage	0.0
Broken top	1.3
Mechanical, stem	0.6
Multiple stem/top	8.0
Top dieback	0.6
Armillaria root disease	0.6
Annosus root disease	0.6
Laminated root rot	0.6
Root disease unknown	0.6
Brown felt foliage disease	0.6
Needle rust	30.5
Cooley gall adelgid	96.0
Needle midge	96.7
Dead/dying trees	3.2

Comments: Several pockets of dead and dying trees affected by laminated root rot were found during the recon survey.

Faultline #11 evaluation plantation Lake Wenatchee District
 Species surveyed Douglas-fir Years planted 8

Trees examined 160 Date surveyed July 10, 1996

Damaging Agents	Percent Trees
No damage	31.9
Broken top	1.2
Mechanical, stem	2.5
Multiple stem/top	6.3
Armillaria root disease	1.2
Laminated root rot	2.5
Root disease unknown	0.6
Cooley gall adelgid	60.0
Needle midge	16.9
Dead/dying trees	4.4

Comments: Pockets of Armillaria and laminated root rot mortality were found in several locations during the recon survey.

Goose Creek evaluation plantation Lake Wenatchee District

Species surveyed Douglas-fir Years planted 7

Trees examined 150 Date surveyed July 10, 1996

Damaging Agents	Percent Trees
No damage	16.7
Frost	0.7
Broken branch	1.3
Broken top	0.7
Mechanical, stem	0.7
Multiple stem/top	7.3
Laminated root rot	1.3
Needle rust	0.7
Cooley gall adelgid	66.7
Needle midge	50.0
Dead/dying trees	1.3

Comments: Pockets of laminated root rot were seen during the recon survey.

Branch Creek evaluation plantation Cle Elum District

Species surveyed Douglas-fir Years planted 15

Trees examined 150 Date surveyed July 23, 1996

Damaging Agents	Percent Trees
No damage	63.3
Broken branch	0.7
Branch dieback	11.3
Stem canker	3.3
Cooley gall adelgid	20.0
Needle midge	5.3
Dead/dying trees	0.0

Comments: This plantation was examined by a forest pathologist in 1992 because several trees were dying and many had branch and top dieback. Many large stem cankers were found during that site visit. Cause of the cankering was not determined. The plantation was thinned to relieve stress from overcrowding.

There has been no indication of additional canker development following the thinning. Cankers on trees left appear to have become inactive. Mortality from Armillaria root disease also stopped following the thinning.

Hard Knox seed orchard Cle Elum District
 Species surveyed Western white pine Years planted 5 & 6
 Trees examined 137 Date surveyed August 2, 1996

Damaging Agents	Percent Trees
No damage	30.7
Animal feeding	3.6
Broken branch	1.5
Broken top	2.9
Top dieback	5.8
Multiple stem/top	4.4
Mechanical, stem	34.3
White pine blister rust	2.2
Aphids	27.0
Dead/dying trees	0.0

Comments: Hard Knox was planted with "rust resistant" seedlings. White pine blister rust infection is common on naturally regenerated white pines surrounding the seed orchard. The incidence of mechanical damage to stems from a variety of causes is quite high.

Hurricane evaluation plantation Cle Elum District
 Species surveyed Douglas-fir Years planted 10
 Trees examined 189 Date surveyed October 8, 1996

Damaging Agents	Percent Trees
No damage	2.1
Snow breakage	1.1
Broken top	2.1
Mechanical, stem	2.1
Multiple stem	0.5
Branch dieback	1.6
Armillaria root disease	1.1
Unknown root disease	0.5
Cooley gall adelgid	92.5
Needle midge	88.3
Dead/dying trees	2.1

Comments: Additional trees killed by Armillaria root disease were found during the recon survey.

Silver Meadows evaluation plantation Cle Elum District
 Species surveyed Douglas-fir Years planted 10
 Trees examined 175 Date surveyed October 7, 1996

Damaging Agents	Percent Trees
No damage	0.6
Snow breakage	1.7

Frost	0.6
Animal feeding	2.9
Broken branch	2.9
Broken top	2.9
Mechanical, stem	1.1
Multiple stem/top	10.3
Branch dieback	0.6
Top dieback	0.6
Brown felt foliage disease	4.6
Cooley gall adelgid	72.0
Needle midge	97.7
Dead/dying trees	1.1

Comments: Mechanical damage from abiotic agents was common in this plantation.

Mt Baker-Snoqualmie National Forest. Two highly developed seed orchards were surveyed. Only Pacific silver fir was surveyed at the Darrington seed orchard even though there are tree species at the site. Only the noble fir planting and one of the white pine planting areas was surveyed at McCullough seed orchard.

Darrington seed orchard	Darrington District
Species surveyed	Pacific silver fir
	Years planted 11 & 12
Trees examined	240
	Date surveyed August 9, 1996
Damaging Agents	Percent Trees
No damage	17.1
Frost	25.0
Animal feeding	0.8
Multiple stem/top	7.9
Top dieback	2.5
Armillaria root disease	0.8
Aphids	1.7
Dead/dying trees	5.0

Comments: A high percentage of the Pacific silver firs in the seed orchard survey exhibited poor tree form. Frost injury is common and quite severe on many trees. Many trees appear to have died within a few years of being planted. There is very little recent tree killing. Very few trees have insects and pathogens.

McCullough seed orchard	White River District
Species surveyed	Noble fir
	Years planted 10
Trees examined	138
	Date surveyed August 12, 1996
Damaging Agents	Percent Trees
No damage	87.1
Frost	2.2
Drought	0.7
Multiple stem/top	5.1
Mechanical, stem	0.7
Foliage rust	0.7
Weevil	0.7

Dead/dying trees 2.2

Comments: Noble firs were in excellent condition at this site. There was almost no foliage disease and no foliage insects.

McCullough seed orchard	White River District
Species surveyed Western white pine	Years planted 8
Trees examined 111	Date surveyed August 12, 1996
Damaging Agents	Percent Trees
No damage	77.5
Multiple stem/top	4.5
Mechanical, stem	0.9
Lophodermium needlecast	12.6
White pine blister rust	0.9
Branch/top dieback	3.6
Aphids	0.9
Dead/dying trees	0.0

Comments: White pines at this site are in excellent condition. Several trees with fresh lateral and top dieback were seen during the recon survey. The damage should be examined by the area entomologist and pathologist to diagnose the cause. Lophodermium needlecast is affecting only old needles.

Okanogan National Forest. There was only one seed orchard established long enough to survey.

Frank Burge seed orchard	Methow Valley District
Species surveyed Ponderosa pine	Years planted 6
Trees examined 211	Date surveyed June 25, 1996
Damage Agents	Percent Trees
No damage	60.2
Animal feeding	1.4
Broken branch	0.9
Mechanical, stem	5.2
Multiple stem/top	4.7
Red band needle blight	26.5
Scythropus weevils	3.3
Aphids	0.9
Pitch moth	0.5
Dead/dying trees	0.5

Comments: Red band needle blight was present on many trees throughout the seed orchard. It was not causing noticeable premature defoliation. Elytroderma needle blight is common on ponderosa pines next to the seed orchard but was not seen on any of the orchard trees. The scythropus weevils bite out chunks of older needles leaving saw-toothed edges. These weevils are having no noticeable effect on the trees.

DISCUSSION

Although many species of insects and pathogenic organisms and abiotic damaging agents were found during this survey, we conclude that there are no serious threats to the seed orchards and evaluation plantations at the present time.

Injuries from a variety of abiotic causes were the most frequently recorded effects in the seed orchards and plantations. Weather, animal feeding, injuries from equipment, and overtopping by brush are common contributors to mechanical injuries. Most of the causes of mechanical damage could not be determined. None of the seed orchards and evaluation plantations seemed to be threatened by mechanical damage.

Tree-killing root diseases were found in 12 of the seed orchards and evaluation plantations. In two instances, Cedar Creek and Branch Creek seed orchards, root diseases had been diagnosed on previous visits but were not found during this survey. Root diseases were found in units that still had stumps from the previous stand, 7 of 9 units, as well as in units from which stumps had been removed, 5 of 12. Laminated root rot was found in 3 sites on the Lake Wenatchee District and a site close by on the Leavenworth District. None of the evaluation plantations where this disease was found had stumps removed. Black stain root disease was found in three Douglas-fir units, two of which had stump removal. Armillaria root disease was found in 7 sites, three of which had stump removal treatments. Armillaria root disease was found on Douglas-fir, Englemann spruce, ponderosa pine, and Pacific silver fir. Annosus root disease was found on 2 Douglas-fir sites, one of which had stump removal. This survey shows that stump removal does not preclude losses of planted trees to root diseases.

Every Douglas-fir seed orchard and evaluation plantation was infested by Cooley gall adelgid and Douglas-fir needle midge, however these insects seemed to have no observable effects on the infested trees other than minor needle discoloration.

Several seed orchards and evaluation plantations had tree infected by needlecast fungi. In all cases the needlecast diseases appeared to have no obvious effect on the growth and survival of infected trees.

The insect and disease situation described by this survey is a snapshot in time that will change. Post occurrence, damage incidence and tree mortality will vary greatly over the lifetime of these sites. Several seed orchards and evaluation plantations experienced more damage, especially tree death, in the first few years of their existence than they are the present time. Some of the root diseases have the potential to spread and kill more trees with the passage of time. Western pine shoot borer has already infested more than half of the trees at the Camas Creek seed orchard on the Leavenworth District but individual infested

trees typically have small numbers of infested branch tips and terminals. This insect could intensify in the ponderosa pine seed orchards and adversely affect seed production.

None of the seed orchards surveyed are old enough to produce meaningful quantities on cones. When the trees achieve cone production capability cone and seed insects are anticipated to become potential problems.

The survey did not identify any serious insect and disease threats to the seed orchards and evaluation plantations. The sites do need to have some level of surveillance to detect potential pest threats. District managers of these sites are doing a good job of evaluating the condition of the trees. They know how to identify most of the damaging agents and they all know they can get diagnostic assistance from agency entomologists and forest pathologists.

APPENDIX

Descriptions and biology of insects and diseases detected in the survey:

Foliage diseases

Brown felt *Herpotrichia juniperi*

Hosts: Most conifers are susceptible. This disease was found only on Douglas-firs in this survey.

Identification: This disease is easy to identify because the fungus forms a thick mat of brown to black mycelium around foliage close to the ground. Needles are bound together in the thick mat.

Effects: The disease kills infected foliage. Infection takes place on foliage buried under snow. Typically the disease is restricted to branches close to the ground. It is possible seedlings could be killed by the disease, but as the trees increase in size the effects decrease.

Comments: There is no need to take actions to reduce the effects of this disease in seed orchards and evaluation plantations. It was found in 4 Douglas-fir evaluation plantations. It is most likely to be found at high elevation sites.

Douglas-fir rust *Melampsora medusae*

Hosts: Douglas-fir. *Populus* species, especially cottonwoods, are alternate hosts required to complete the life cycle.

Identification: The fungus forms tiny bright yellow pustules of spores on needles. They are present only during summer months.

Effects: Infection causes yellow spots on foliage. Infection probably causes premature needle death.

Comments: There is no need to take actions to reduce the effects of this disease in seed orchards and evaluation plantations. It is most likely to be found in sites with cottonwood growing in

the immediate vicinity. Infection is likely to be most frequent in dense stands that experience long periods of high relative humidity. It was found in only 2 evaluation plantations in this survey.

Red band needle blight *Mycosphaella (Dothistroma) pini*

Hosts: Pines. This disease was found only on ponderosa pine in this survey.

Identification: The disease results in small yellow spots of no diagnostic value within a few months of infection. In the fall the disease can be identified by distinctive red brown bands 1/4" to 1/3 " long on infected needles.

Effects: Infection results in needle discoloration and premature needle loss.

Comments: This disease was found on 26 percent of the trees at the Frank Burge seed orchard on the Methow Valley District. Although the infection rate was high the disease did not appear to be affecting foliage retention or growth. The disease should be monitored at that seed orchard.

Rhabdocline needlecast *Rhabdocline pseudotsugae*

Hosts: Douglas-fir.

Identification: The best time to identify this disease is in the spring. Infected one-year old needles have distinctive deep red to purple blotches. Small orange-lipped slit-like fruiting bodies form in the blotches on the undersides of infected needles. Symptoms are almost always most noticeable on foliage close to the ground. In the summer infected trees will look sparse and there will be fallen needles on the ground.

Effects: Infected needles are killed and fall in the summer one year after infection. Severe persistent infection can reduce tree growth. Tree mortality in seed orchards and evaluation plantations would be uncommon and most likely be confined to small trees.

Comments: This disease was found in 3 Douglas-fir sites during the survey, but only the Cedar Creek seed orchard on the Colville District had a high rate of infection (70%). This disease will not be a management concern in most Douglas-fir seed orchards and evaluation plantations. There is evidence that some Douglas-firs have genetically based resistance to infection. There would be merit in removing trees showing severe, persistent infection during roguing operations in seed orchards. The disease will be found most frequently in Douglas-fir sites that are exposed to long periods of high relative humidity, especially fog, in the spring during foliage flush.

Swiss needlecast *Phaeocryptopus gaumanni*

Hosts: Douglas-fir

Identification: Infected one year and older needles have tiny black fruiting bodies in the white stomatal rows on the underside of needles. They can be confused with the much bigger black to gray eggs and nymphs of Cooley gall adelgids.

Effects: Infection results in needle discoloration and premature needle death. However, needles may be infected for 1 or more years and still remain green and alive.

Comments: This disease was found on only two trees and seemed to have no effect on them. Undoubtedly the infection rate is higher than we found but it is also clear this disease is not presently a management concern in the Douglas-fir sites surveyed. The disease is more likely to be found in western Washington than in the drier eastern portion of the state.

Root Diseases

Annosus root disease *Heterobasidion (Fomes) annosum*

Hosts: Conifers. The disease was found only in Douglas-fir on this survey.

Identification: Tough white to cream-colored conks at the root collar of recently killed trees are the most reliable diagnostic aids. The fungus also forms pustules on infected roots.

Effects: Infection of the entire root system results in tree death.

Comments: Annosus root disease was found at a very low frequency on this survey. Incidence of damage could increase as the planted trees get bigger and come in contact with infected roots of trees that previously occupied the sites. The disease is most likely to be found on sites where stump removal was not done and it is most likely to be found in sites planted with pines.

Removal of dead trees and their roots could reduce spread potential in seed orchards.

Armillaria root disease *Armillaria ostoyae*

Hosts: All conifers.

Identification: Thick white sheets of mycelium under the bark of dead and dying trees are the best indicators of Armillaria root disease in seed orchards and evaluation plantations. Severely infected Douglas-fir commonly exudes pitch at the root collars. The fungus may produce golden colored fleshy mushrooms at the base of dead trees in the fall. They are not persistent.

Effects: Infection of most of the root system results in tree death.

Comments: This is the most commonly found root disease in seed orchards and evaluation plantations. Dead and dying infected trees and their roots should be removed from seed orchards to reduce the potential of spread to adjacent trees.

Black stain root disease *Leptographium (Verticicladiella) wageneri*

Hosts: Douglas-fir and pines. The disease was found only in Douglas-fir in this survey.

Identification: This disease is diagnosed by the black to dark brown stain in the stem and root wood of dying and recently dead trees. The stain tends to occur in arcs that follow annual rings.

Effects. Infection results in tree death.

Comments: Black stain root disease was found at two Douglas-fir sites. The Duncan Ridge seed orchard and evaluation plantation on the Entiat District contains several infection centers. This disease has been considered less common than the other root diseases in eastern Washington.

Laminated root rot *Phellinus weirii*

Hosts: Conifers. This disease is most common on Douglas-fir.

Identification: The fungus forms a thin coating of white to cream colored mycelium on the exterior of infected roots. Red-brown hairs can be seen in the mycelium with a 10X lens. Wood decayed by the fungus separates into sheets at the annual rings. These sheets are pitted on both sides and contain the red-brown hairs. Effects: Infection results in tree death. Large trees may be windthrown.

Comments: Laminated root rot was found in 4 Douglas-fir evaluation plantations on the Lake Wenatchee and Leavenworth Districts. Stump removal had not been done at any of these sites. All of the dead trees were closely associated with stumps. Tree killing is likely to continue at sites where it was found. It may also begin to appear at other sites as the trees reach sizes big enough for their roots to contact inoculum from the previous stands and become infected.

Stem and Branch Diseases

Comandra blister rust *Cronartium comandrae*

Hosts: Ponderosa pine. Alternate host *Comandra* species, bastard toadflax.

Identification: This disease causes spindle shaped swellings on branches and stems. Pustules of bright orange spores may be found on active infections for brief periods in the summer. This disease can be confused with western gall rust, which forms more rounded swellings.

Effects: The disease can result in killing of distal portions of infected branches and stems.

Comments: Comandra blister rust is uncommon in ponderosa pine seed orchards and evaluation plantations in eastern Washington. It was found on only one tree in this survey. If infected trees are found in seed orchards they should be removed.

Dermea canker *Dermea pseudotsugae*

Host: Douglas-fir.

Identification: The disease causes branch and stem cankers. Active cankers have red edges. Tiny black undistinctive fruit bodies may form on dead bark in the cankers.

Effects: Infection results in cankers that can kill branches and stems.

Comments: This disease was confirmed only at the Flowery Trails seed orchard on the Newport District. Many trees have been affected. It is suspected, but unconfirmed, as the cause of

cankering at the Branch Creek evaluation plantation on the Cle Elum District. At Flowery Trails the fungus appears to be infecting trees through shallow feeding galleries made by the Douglas-fir bark miner, *Laspeyresia pseudotsugae*. The disease is likely to be most common on droughty sites and stands with severe competition.

Lophodermium needlecast *Lophodermium pinastri* complex

Hosts: Pines. This disease was seen only on western white pine in this survey.

Identification: Exact identification is difficult. Black elliptical fruiting bodies are formed in rows on 3 year and older needles. Infected needles turn gray and may remain on the trees for several years.

Effects: This disease has little effect on trees because it infects and kills old needles.

Comments: This disease was found only on white pines at the McCullough seed orchard, however it is quite common on pines in eastern Washington. It was only on old needles and did not appear to be adversely affecting trees. There is no need to take actions to deal with this disease in pine seed orchards.

Sirococcus tip blight *Sirococcus strobilinus*

Hosts: Lodgepole pine.

Identification: The disease causes small purple cankers on new shoots. Affected shoots curl and form crooks.

Effects: Infection results in shoot killing.

Comments: This disease was previously found on a small number of trees at the Cedar Creek seed orchard on the Colville District. It was not found on any trees during the 1996 survey. The disease would most likely be found at wet sites, which are uncommon in eastern Washington.

Western gall rust *Endocronartium (Peridermium) harknessii*

Hosts: Ponderosa pine, lodgepole pine.

Identification: The fungus forms round woody galls on branches and stems. Pustules of orange yellow spores are produced on live infections in the summer months.

Effects: Distal portions of infected branches and stems may die. Many infected branches and stem remain alive for many years and the galls become larger with time. Stems may break off at old galls.

Comments: Western gall rust was found only at the Mud Creek seed orchard on the Entiat District. It was not found in the one lodgepole pine seed orchard surveyed even though lodgepole is much more commonly infected than ponderosa pine in eastern Washington.

White pine blister rust *Cronartium ribicola*

Hosts: Western white pine. Alternate host *Ribes* species.

Identification: The fungus forms spindle-shaped swellings on branches of white pine. Active infections have distinctive

yellow-green margins. Old swellings have a cracked roughened appearance. Stem infections have copious resin flow. Late in the spring pustules of yellow-orange spores are formed on infections.

Effects: Blister rust infections kill branches, tops, and whole trees.

Comments: Blister rust was found at both white pine seed orchards surveyed. Both were planted with "rust resistant" trees. Infection is likely to increase somewhat at the Hard Knox seed orchard at Cle Elum because there are many infected trees adjacent to the seed orchard. Infection is less likely to increase at the McCullough seed orchard on the White River District due to the size of the trees and their spacing.

Insects

Douglas-fir bark miner *Laspeyresia pseudotsugae*

Host: Douglas-fir.

Identification: Damage caused by this small insect is easy to identify. It forms sinuous, very shallow feeding galleries in living bark on Douglas-fir saplings. The galleries are typically orange to brown.

Effects: Most of the galleries have no apparent effect on the trees because they are confined to the outermost living bark tissues and do not penetrate into the wood. A small number of the galleries at the Flowery Trail seed orchard appear to have served as infection sites for the *Dermea* canker.

Comments: This insect is common and generally is of no consequence. There is no need to take actions to reduce the incidence of the insect. There are no known controls because there has been no need.

Cooley spruce gall adelgid *Adelges cooleyi*

Hosts: Douglas-fir and Englemann spruce. The insect alternates between these two conifers.

Identification: Douglas-fir, The insect most commonly is seen as small balls of white wax which looks like cotton on needles. The crawler stage of the insect appears as round black to gray dots on the undersides of needles. Feeding damage appears as small yellow spots extending the entire width of needles. Englemann spruce, The insect forms very distinctive galls on branch tips of spruce. The galls have a cone shape. At first the galls are green and then turn bright red to purple. Nymphs can be found in chambers inside the galls. Old galls persist on trees and turn brown to gray.

Effects: Cooley gall adelgids cause yellow spots on Douglas-fir needles. Severe feeding can result in premature needle death and could slow the growth of seedlings. This insect is rarely responsible for killing Douglas-firs. Aside from the galls it causes, the insect does not seem to have any serious effects on spruce. The shape of spruce trees could be altered by gall formation on branch tips and terminals. Severe and repeated

infestations of spruce could indirectly reduce cone production by destroying cone production sites.

Comments: Cooley gall adelgid was found on large percentages of the trees in every Douglas-fir and Engelmann spruce seed orchard and evaluation plantation. Nevertheless, it appears to be having very little effect on the trees. There is no need to take actions to reduce the incidence of Cooley gall adelgid in these facilities.

Douglas-fir needle midge *Contarinia* species

Hosts: Douglas-fir.

Identification: Infested needles have sharply defined red, purple, or yellow bands or galls about 1/4" to 1/3" long.

Typically, the needles have a definite angle or bend at the gall. The galls are hollowed by insect feeding. Tiny yellow maggots can sometimes be found in the galls in summer months.

Effects: The most visible effect is the banding on infested needles. Infested needles die prematurely. In severe infestations trees can experience noticeable defoliation. This was not seen on any of the infested trees in this survey.

Comments: Douglas-fir needle midge was found in every Douglas-fir seed orchard and evaluation plantation. In most units high percentages of the trees were infested. However, none of the infested trees appeared to be experiencing obvious defoliation. These insects do not appear to be a threat to the Douglas-fir orchards and plantations at the present time.

Red turpentine beetle *Dendroctonus valens*

Hosts: Pines. It was found only on ponderosa pine in this survey.

Identification: Red turpentine beetle attacks can be recognized by the presence on quarter to half dollar size globs of red to pink colored pitch within 18" of the ground on pines. The adult beetles are red brown and relatively large, averaging about 1/4".

Effects: Red turpentine beetles typically do not kill trees by themselves. They are attracted to wounded or stressed trees.

Trees with multiple attacks around the lower bole may be killed.

Comments: Red turpentine beetle attacks were found on only three trees in the survey. All infested trees had mechanical injuries or fire damage. Avoidance of mechanical injuries to pines should continue to protect trees from this insect.

Sequoia pitch moth *Vespa mima sequoiae*

Hosts: Pines. It was found only on ponderosa pine in this survey.

Identification: Sequoia pitch moth attacks can be identified by large globs of pitch around branch/stem junctions and wounds.

Larvae can be found inside fresh pitch globs in summer months.

Adults are clear winged black and yellow moths that look like wasps.

Effects: Attacks by sequoia pitch moths seldom kill trees because feeding is restricted to small areas of the cambium.

Comments: This insect was found only on trees that had been injured by other causes. It could be attracted to pruning

injuries.

Scythropous weevil *Scythropus* species

Hosts: Pines. It was seen only on ponderosa pines in the survey.

Identification: These weevils feed on old pine foliage by chewing out chunks on one side up to 1/2" long. Edges of the chewing have a sawtooth appearance.

Effects: These insects seem to have almost no effect on the trees because very small numbers of needles are chewed.

Comments: This insect is of no consequence in pine seed orchards and evaluation plantations in eastern Washington.

Spruce weevil *Pissodes strobi*

Hosts: Englemann spruce

Identification: This insect kills the tops of trees. Tops often have crooks. The inner bark of dead tops is obviously eaten and there are oval shaped cells of finely chewed chips where the insects pupate.

Effects. Infested tops are killed.

Comments: Damage caused by spruce weevils was not seen during the survey but had been observed on an earlier visit to the Tee Pee seed orchard on the Sullivan Lake District. Spruce seed orchards and evaluation plantations should be monitored for damage.

Western pine shoot borer *Eucosma sonomana*

Hosts: Ponderosa pine.

Identification: Laterals and terminals infested by western pine shoot borer usually are killed. Needles on infested, but living shoots are shorter giving a "shaving brush" appearance. Larvae mine the pith of infested shoots and pack the tunnel with frass.

Effect: Infested shoots usually are killed, however some survive and are shorter than uninfested shoots. Severe infestations can reduce height growth of trees and alter the form. Cone production could be reduced as branch tips are killed.

Comments: More than half the trees at Camas Creek and several at Mud Creek have been attacked by western pine shoot borers.

Although the number of branches affected on infested trees appears to be small, this insect has the potential to adversely affect cone production in the future. Damage frequency can be reduced by application of mating disruption pheromones.